

## **Langley's DEVELOP Team Applies NASA's Earth Observations to Address Environmental Issues Across the Country and Around the Globe**

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### **Introduction**

The DEVELOP National Program was established over a decade ago to provide students with experience in the practical application of NASA Earth science research results. As part of NASA's Applied Sciences Program, DEVELOP focuses on bridging the gap between NASA technology and the public through projects that innovatively use NASA Earth science resources to address environmental issues. Cultivating a diverse and dynamic group of students and young professionals, the program conducts applied science research projects during three terms each year (spring, summer, and fall) that focus on topics ranging from water resource management to natural disasters.

Headquartered at Langley Research Center (LaRC), DEVELOP has grown from a small team of three students in 1998 to a national program providing over 200 internship opportunities nationally each year. There are currently nine DEVELOP offices - six in association with NASA centers - Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, Marshall Space Flight Center, and Stennis Space Center - and three in regional offices - Mobile County Health Department (AL), Wise County Clerk of Court's Office (VA), and the Great Lakes and St. Lawrence Cities Initiative (IL). DEVELOP teams conduct projects under the guidance of science advisors from NASA and partner organizations that address national priorities and local environmental concerns, utilize NASA Earth observations, and provide end-users with tools for enhanced decision making. Research is done in association with regional, national, and global partners and aims to identify the widest array of practical uses for NASA data to help communities better understand environmental change over time.

Langley is home to DEVELOP's National Program Office (NPO) which oversees DEVELOP's national activities, and hosts the largest number of DEVELOP students each year. Aligning with Langley Research Center's core competency in atmospheric science, multiple projects have been conducted focusing on air quality monitoring the United States and around the world. Langley DEVELOP students have also conducted numerous projects focusing on sea level rise and storm surge along the Eastern Seaboard, including the Hampton Roads area where LaRC is located. These projects have partnered with local, regional, and international partners to extend the user community of NASA Earth science data and technology, while providing students and young professionals research experience.

### **Air Quality Research**

Since DEVELOP's inception, the Langley DEVELOP team has conducted over a dozen different projects focused on enhanced monitoring of air quality on both local and regional scales. This research was done under the guidance of NASA atmospheric scientists at Langley Research Center, and has allowed students to learn not only about NASA's contributions to monitoring air quality through use of satellites such as the Moderate Resolution Imaging Spectroradiometer (MODIS), Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), and Ozone Measuring Instrument (OMI), but also airborne missions like the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites - California Air Resources Board (ARCTAS-CARB).

The recent *China Health: Monitoring aerosol changes over Eastern China using NASA Earth observations* project that took place in the 2011 spring term concentrated on the evaluation of different monitoring

methods of aerosol optical depth (AOD) in Linfen, China, to assist in improved air quality management. Eastern China is home to a population of approximately one billion people, concentrated in large metropolitan areas with coal providing the majority of energy. Due to the large amount of aerosol emissions related to coal burning, air quality is a major concern in many cities including Linfen, the capital of the Shanxi Province. Students investigated capabilities of Aqua MODIS and CALIPSO Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) imagery to monitor aerosols. They also used NOAA's Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model to create trajectories of potential aerosol movement. This research benefits China and organizations attempting to monitor air quality within the country, because currently China has no ambient air quality standards for PM<sub>2.5</sub> (particulate matter with particle diameter of 2.5 microns or smaller) despite numerous negative effects upon human health. "I learned a great deal about the capabilities and limitations of satellite remote sensing in regards to measuring air quality levels. It was a good learning experience in how to conduct a research project, lead a research team, and work with students from different disciplines than my own," said **MyNgoc Nguyen** [Langley DEVELOP/Old Dominion University - *Student & Project Co-Lead*]. "With only ten weeks to conduct the project, the team experienced the true meaning of both teamwork and flexibility." [\[Image 1 goes with this paragraph\]](#)

Another air quality project that took place in the 2010 summer term, *California Natural Disasters: Using remote sensing data to assist management at Angeles National Forest* investigated degraded air quality levels stemming from the Angeles National Forest wildfires during the summer of 2009, as well as smoke plume trajectory modeling and associated health risks. The team utilized Terra's ASTER, MODIS, as well as data from EPA's AirNow system, CARB AQMIS, and ARCTAS CARB flights to observe air quality factors such as PM<sub>2.5</sub> levels, AOD, trace gases, and UV aerosol index. The results obtained from this study demonstrated the feasibility and applications of NASA satellites and airborne missions for enhanced decision support to the US Forest Service at Angeles National Forest and the South Coast Air Quality Management District, the project's partners. Students also investigated all aspects of the disastrous fire including fuel loading, burn extent, and impacts to public health. **Malcom Jones** [Langley DEVELOP/Christopher Newport University - *Student & Project Lead*] found that "Using a suite of NASA's sensors to look at different aspects of the Angeles National Forest fire was extremely fascinating. Even though I am a Computer Engineering major, being able to work with other students and scientists in areas concerning air quality and ecological forecasting allowed me to see how I can apply my knowledge to a wide array of problems in the real world." [\[Image 2 and 3 go with this paragraph\]](#)

### Sea Level Rise & Storm Surge Studies

Langley Research Center's coastal location on the Eastern Seaboard makes sea level rise and storm surge inundation an important topic. LaRC suffered major damage from Hurricane Isabel in 2003, and was recently tasked by NASA's Climate Adaptation Science Investigation (CASI) team to investigate the effects that projected climate change could have on the center and what type of adaptations could potentially help abate impacts. The DEVELOP team conducted the *Langley Climate Change and Adaptation: Strategies to counter predicted climate change effects on NASA Langley Research Center* project, which focused on improved storm surge modeling and the relating impact inundation could have on Langley infrastructure. This project assisted the Langley Science Directorate with improved forecasting and prioritization of assets for protection. Students gained experience with geographic information science (GIS), the creation of multiple sea level rise scenarios, and practice utilizing climate models. They also were able to understand the impact storm surge and sea level rise would have on the very buildings they were working in, making their research of even higher interest and importance. "Analyzing tropical cyclone data has allowed us to quickly evaluate the types of storms that have affected the study area," says **Nathaniel Makar**, [Langley DEVELOP/Pennsylvania State University -

*Student & Project Lead*] “As a Meteorology major, this project gives me great experience applying what I have learned in school to real world situations.” [\[Images 4 and 5 go with this paragraph\]](#)

A second project Langley students conducted was the *Outer Banks Climate: Assessing and establishing a process for understanding coastal changes in North Carolina* project that investigated the use of NASA EOS such as Jason-1, TOPEX/Poseidon, Landsat 5’s Thematic Mapper (TM), and Terra’s ASTER, to monitor North Carolina’s dynamic and ever changing Outer Banks estuarine systems. Rising sea levels and tropical cyclonic events have caused erosion and shore loss threatening entire coastal communities. The team partnered with the North Carolina Division of Coastal Management (NCDCM) to conduct research focusing on estuarine shoreline issues, including development of shoreline identification techniques, quantification of development trends along the shoreline, shoreline movement trend analysis, and considering all of the above within the overarching theme of sea level rise. “The potential benefits of this investigation to our coastal program are numerous and far reaching. The implications of creating analytical procedures for remotely sensed data from NASA satellite platforms allows an exciting opportunity for North Carolina to better manage its estuarine shoreline and plan for and manage future development patterns in the context of sea level rise,” said Dr. Jeffrey D. Warren [NCDCM - Coastal Hazards Specialist], “We are also eager to continue this work into future DEVELOP sessions to build on what I feel is groundbreaking research directly applicable to our State’s coastal management efforts.” [\[Image 6 and 7 go with this section\]](#)

## **Conclusion**

As DEVELOP’s summer term begins in early June this year, students at Langley Research Center will continue to learn and expand their knowledge of NASA’s Earth observations capabilities in relation to air quality and sea level rise monitoring. Challenged to creatively and innovatively apply NASA’s satellite and airborne Earth observations to real-world issues, Langley DEVELOP students are gaining tangible skills and knowledge that will help them in their future careers.

More information is available about the DEVELOP National Program at [develop.larc.nasa.gov/](http://develop.larc.nasa.gov/). Information about NASA’s Applied Sciences Program is available at [appliedsciences.nasa.gov/](http://appliedsciences.nasa.gov/), and Langley’s Science Directorate at [science.larc.nasa.gov/](http://science.larc.nasa.gov/).

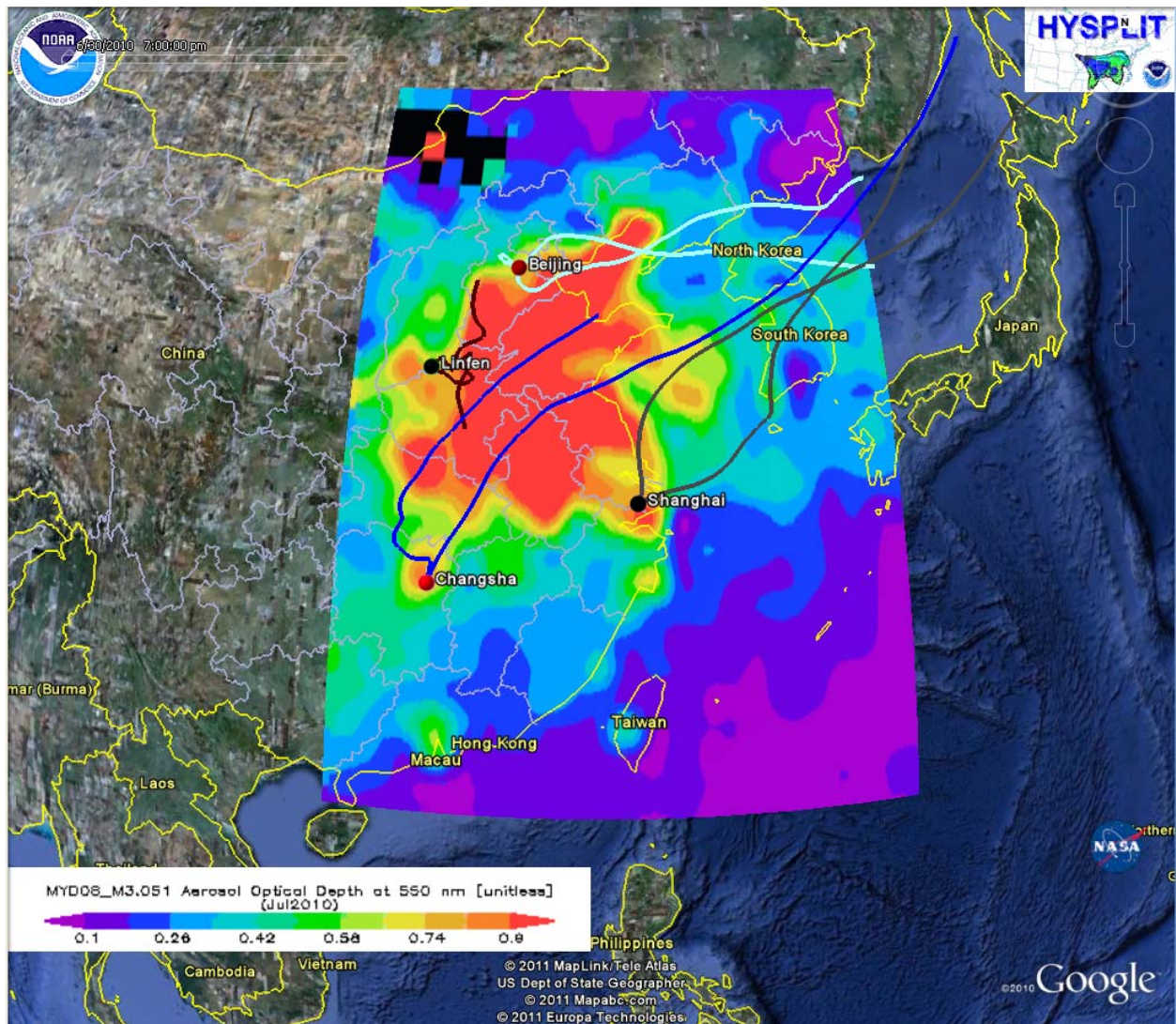


Image 1. Aqua MODIS Aerosol Optical Depth (AOD) measurements and HYSPLIT trajectories displayed in Google Earth provide enhanced air quality monitoring and projected aerosol movement.



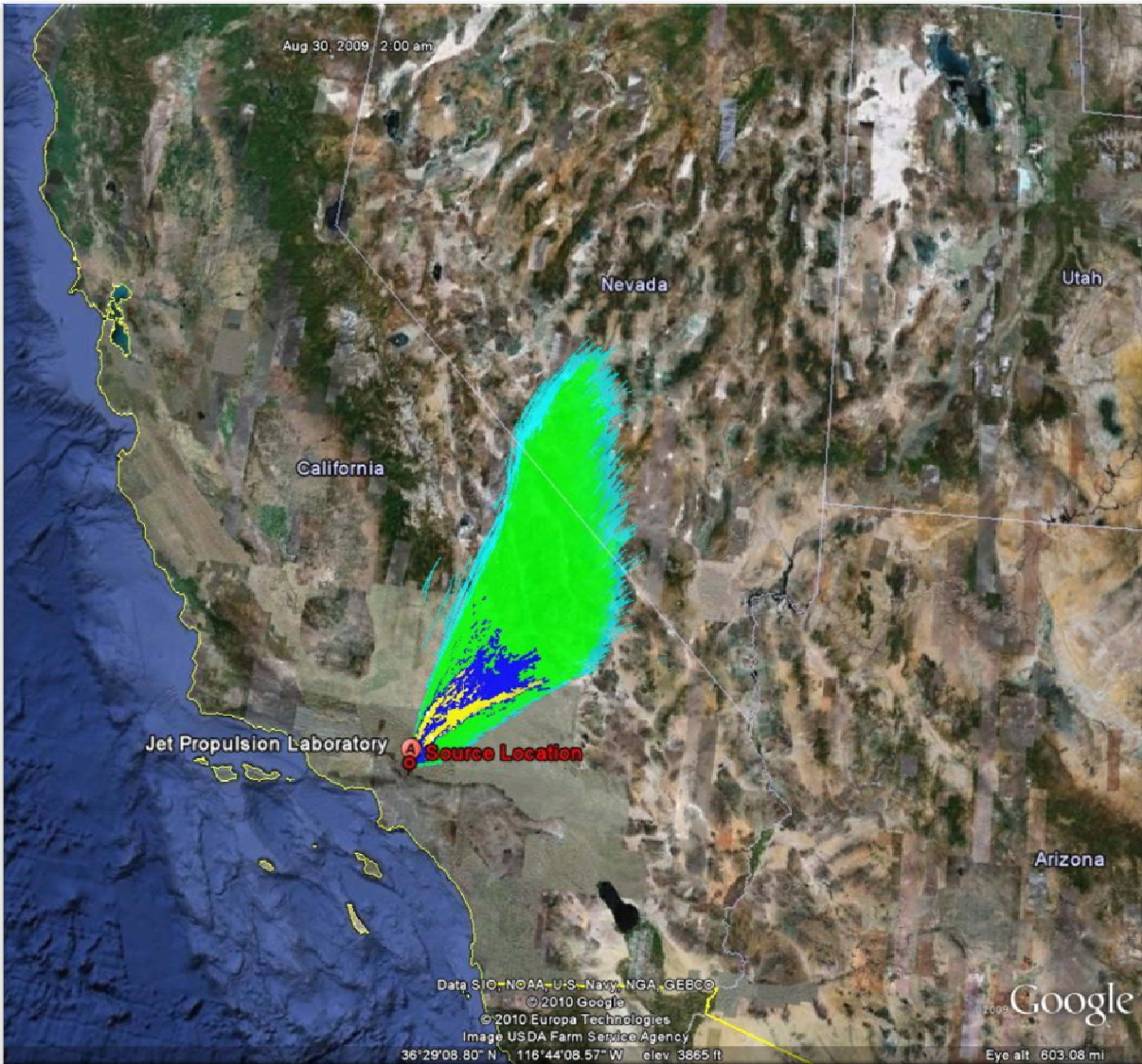


Image 2. HYSPLIT Dispersion model for August 29<sup>th</sup>, 2009 in Google Earth.

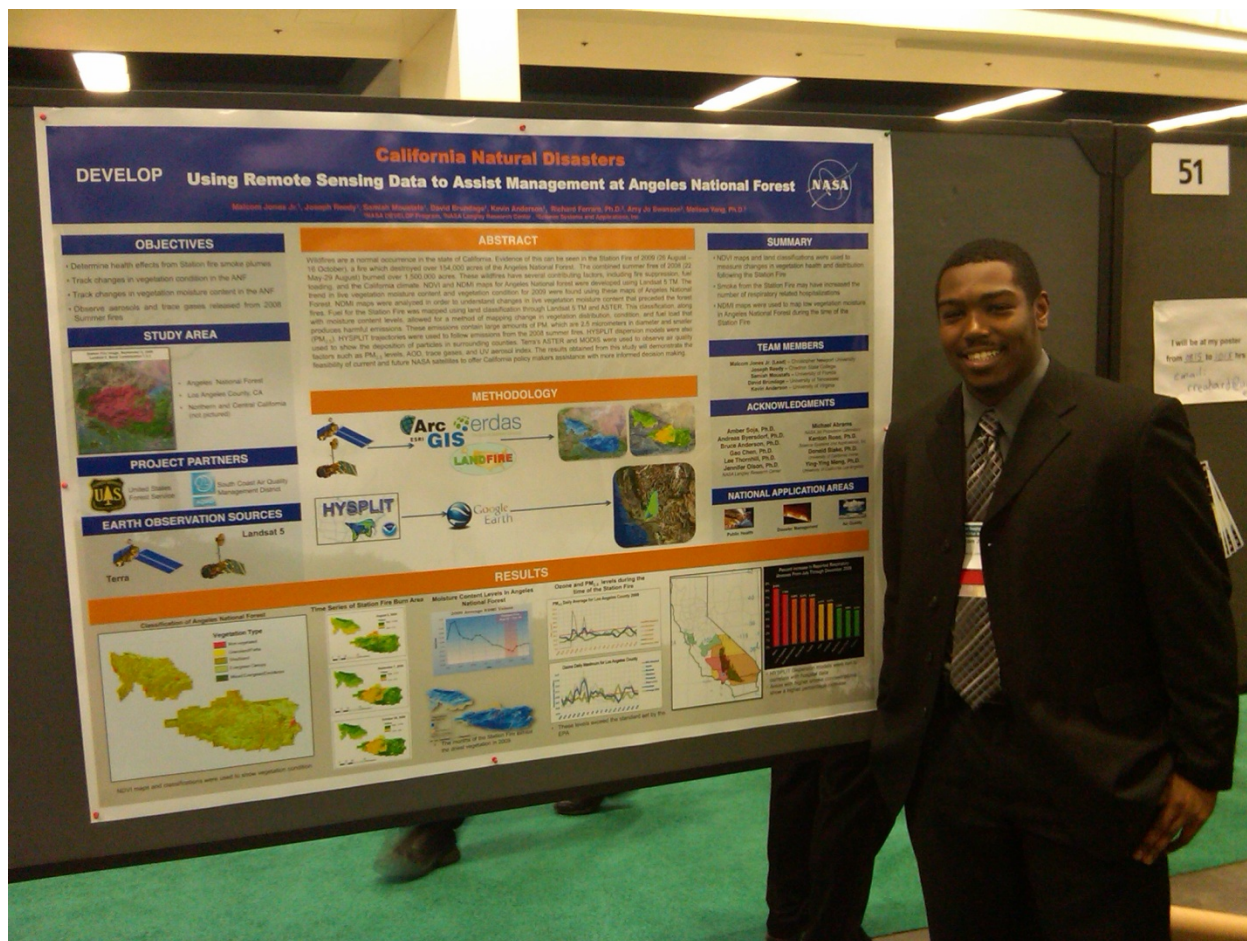


Image 3. Langley DEVELOP student Malcom Jones presents the summer 2010 California Air Quality project poster at the American Geophysical Union (AGU) Fall Meeting in San Francisco, CA in Dec 2010.



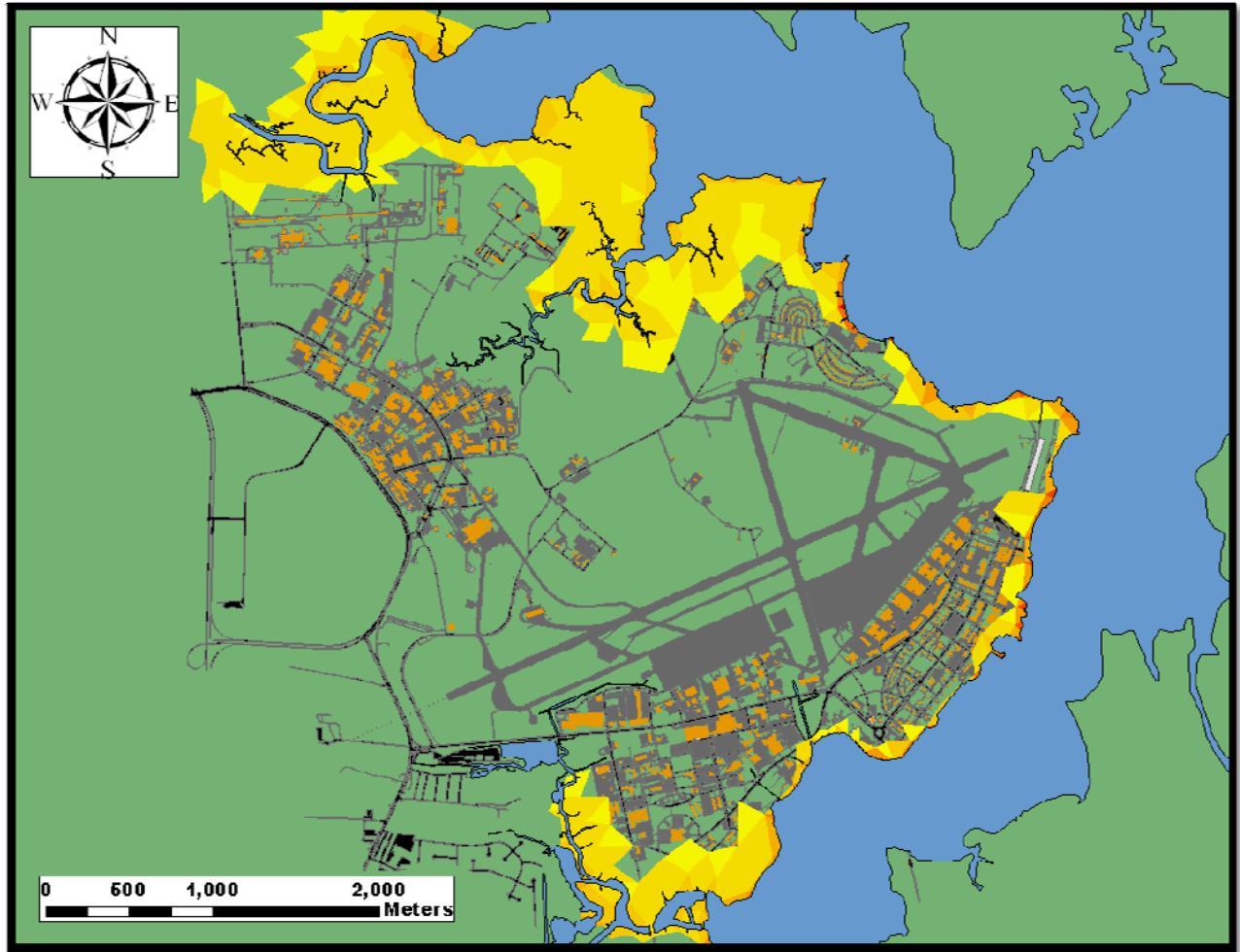


Image 4. Hurricane Isabel storm surge inundation on Langley Research Center and infrastructure at risk.

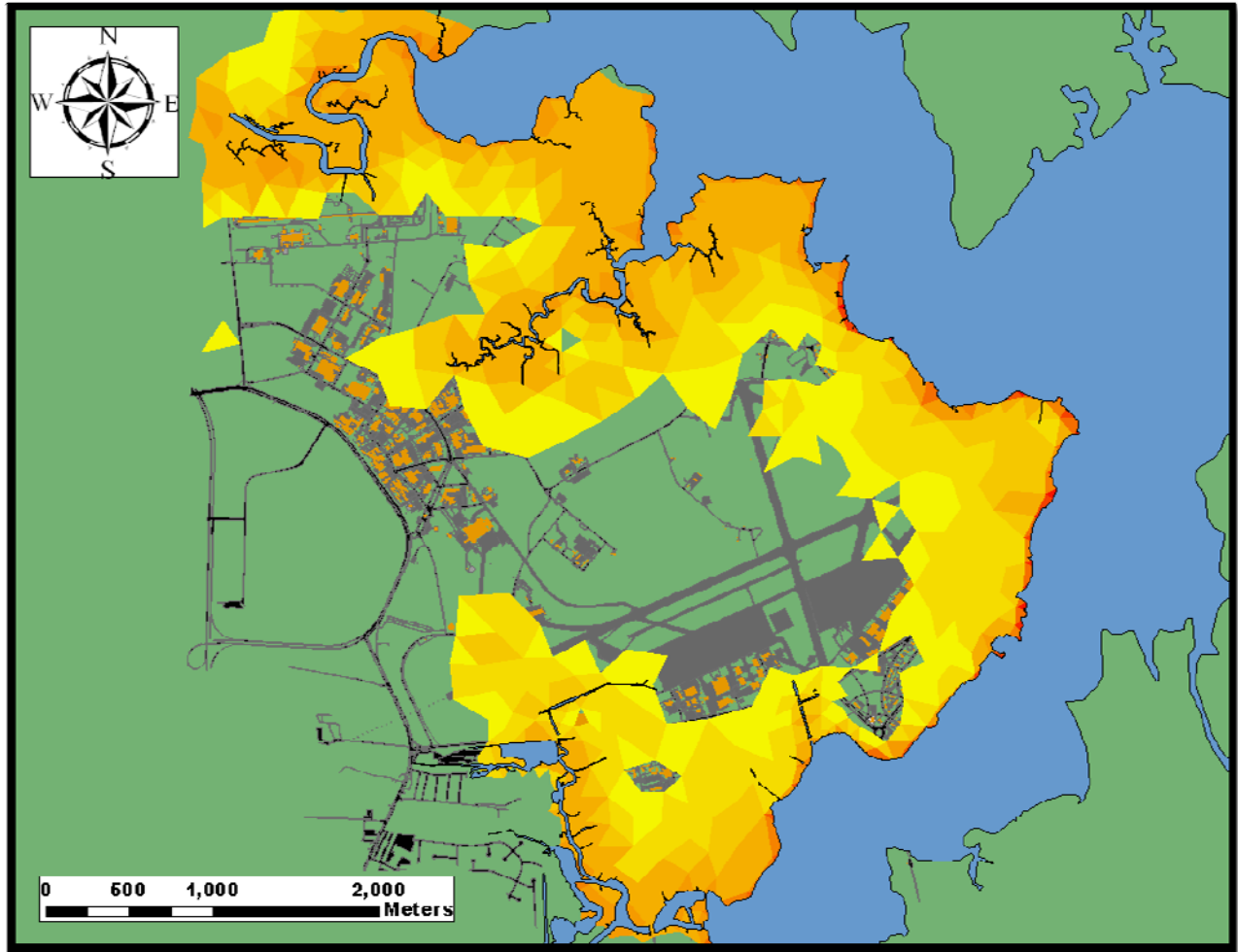
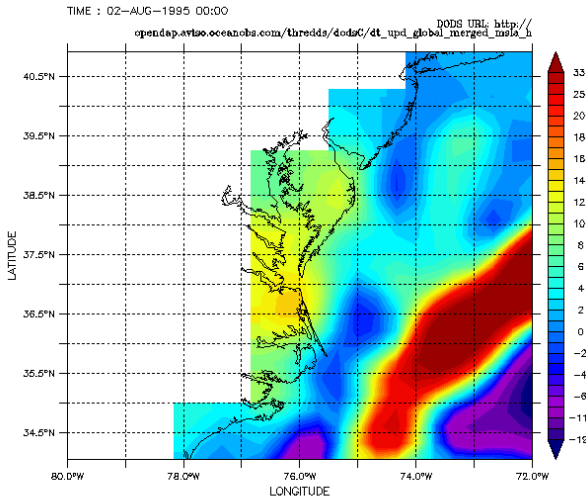
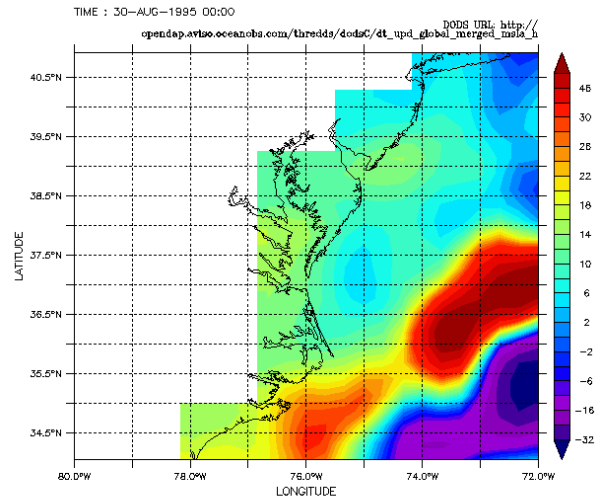


Image 5. Projected sea level rise of 100cm (year 2070-2080) receiving a storm surge inundation similar to Hurricane Isabel levels at Langley Research.

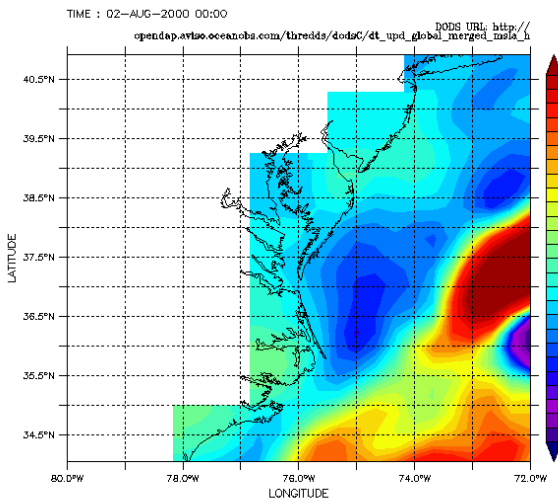




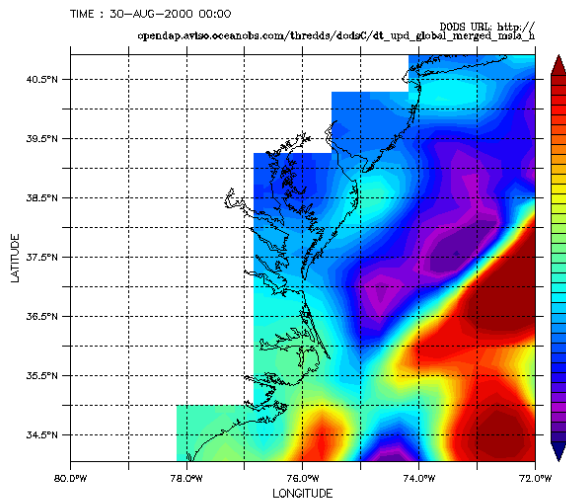
Maps of Sea Level Anomalies Merged (cm)



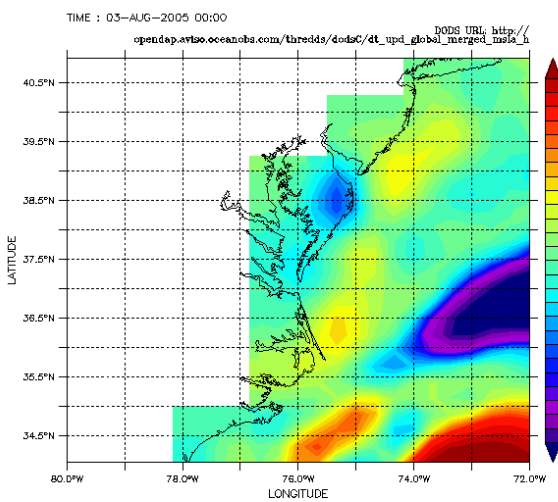
Maps of Sea Level Anomalies Merged (cm)



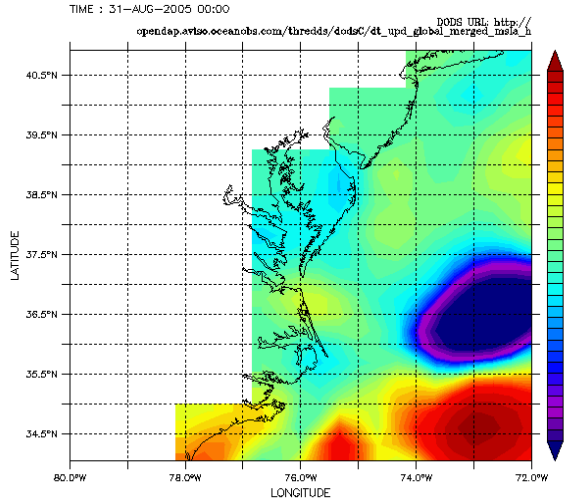
Maps of Sea Level Anomalies Merged (cm)



Maps of Sea Level Anomalies Merged (cm)



Maps of Sea Level Anomalies Merged (cm)



Maps of Sea Level Anomalies Merged (cm)

Image 6. Sea Level measurements from Jason-1 and TOPEX/Poseidon along the North Carolina coastline.



Image 7. Langley DEVELOP's Summer 2010 Outer Banks Climate project team - (left to right) Dominique Norman, Conor Collins, Chelsea Burns, Derek Doddridge, and Kristin Morgan.